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Understanding Interdisciplinarity: Curricular and Organizational Features of Undergraduate Interdisciplinary Programs

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Abstract Though the number of interdisciplinary undergraduate programs has increased rapidly over the past several decades, little empirical research has characterized such programs. In this article we report on our investigation of the characteristics of interdisciplinary programs and develop typologies to describe the multiple ways in which such programs are structured with respect to curricular and organizational features. Using cluster analysis, we show differences in both curricular structures and organizational features across programs, irrespective of the program's content focus. This typology will guide future research to explore differences in student learning outcomes across the interdisciplinary program types.

Keywords Interdisciplinarity · Curricular typology · Organizational features

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A review of recent policy documents from the U.S. government reveals a consistent call for greater investment in interdisciplinary education (e.g. National Academy of Sciences 2004; National Institutes of Health 2006). These calls are based on the assumption that interdisciplinary educational approaches foster innovation more effectively than do discipline-based educational programs (National Academy of Engineering 2004; U.S. Department of Education 2006). This shift toward interdisciplinary education is presumed to promote global competitiveness, national security, and economic prosperity (National Academy of Engineering 2004; National Science Board 2010; U.S. Department of Education 2006).

Substantial growth in interdisciplinary undergraduate programs suggests considerable confidence in this educational approach that predates most of these of these policy directives. Brint et al. (2009) documented the growth in interdisciplinary undergraduate programs between 1975 and 2000. The total number of interdisciplinary majors grew by nearly 250% during this time period, outstripping an 18% increase in college and university enrollments during the same period. Despite this growth, little empirical research has been conducted to characterize these new programs. Unlike disciplines, which provide norms that codify structures and curricula (e.g., Kuhn 1970), research has not explored whether or not there are structural norms in interdisciplinary fields. We take up that cause in this article, developing typologies of interdisciplinary programs to describe the multiple ways in which they are structured, with respect to both curricular and organizational features.

Though developing a better understanding about the context of interdisciplinary programs represents an important contribution to the literature, our work is also of importance because it informs future research on student learning in interdisciplinary programs. Because organizational and curricular features influence student learning outcomes (e.g., Terenzini and Reason 2005, 2012), researchers must first understand the characteristics of interdisciplinary programs in order to be able to conduct systematic studies of student learning in such programs. Although advocates of interdisciplinary programs have argued that integrating interdisciplinarity into undergraduate curricula better prepares students for the workforce and for civic participation by facilitating the development of problem solving and critical thinking skills (Hursh et al. 1983; Newell 1990; Newell and Green 1982), few studies support the claim that interdisciplinary curricula have positive effects on learning (Lattuca et al. 2004). Consequently, some scholars have questioned whether interdisciplinary education is superior to discipline-based education (Benson 1982; Fish 1989; Jacobs and Frickel 2009). This study lays the groundwork for future research that could provide systematic and methodologically robust assessments of the effects of interdisciplinary study on college students' learning and development.

Defining Interdisciplinarity and Interdisciplinary Programs

A variety of educational approaches exists in interdisciplinary programs (Augsburg and Henry 2009; Klein 2010a), in part because of the indeterminacy of the term "interdisciplinary" (Klein 2010a; Lattuca 2001; Lattuca and Knight 2010; Moran 2010; Repko 2008; Weingart and Stehr 2000). A common distinction differentiates "multidisciplinarity" from "interdisciplinarity." Typically scholars argue that multidisciplinarity brings two or more disciplines to bear on a problem without integrating disciplinary components, whereas interdisciplinarity is marked by a synthesis of disciplinary knowledge and methods that provides a more holistic understanding (Collin 2009; Klein 1996; Kockelmans 1979; Miller 1982; O'Donnell and Derry 2005; Richards 1996). Interdisciplinarity is understood to be:

> …a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession … [by] draw[ing] upon disciplinary perspectives and integrat[ing] their insights through construction of a more comprehensive perspective (Klein and Newell 1997, p. 393–394).

In practice, most faculty members are either unaware of or unconcerned with such distinctions and tend to use the terms interchangeably (Adams et al. 2007; Aram 2004; Carp 2001; Holley 2009; Lattuca 2001; Lattuca and Knight 2010). Variations in the use of the term suggest that faculty members in the same educational programs have differing views of what an education that stresses interdisciplinarity entails (see Carp 2001; Holley 2009; and Lattuca and Knight 2010). Although interviews with faculty members are one way to capture such differences in understanding, another way of studying the views of faculty members is to examine the actual curricula of interdisciplinary programs.

However, determining which academic programs are indeed interdisciplinary presents challenges. Klein (2010b) reviewed the multiple taxonomies that organize interdisciplinarity so as to differentiate between education and knowledge. She argued that, although such taxonomies are important to benchmark practices and identify patterns of change, it is difficult to establish concrete, static typologies because boundaries between interdisciplinary fields are dynamic and constantly blurring. In developing one such classification system to measure changes in interdisciplinary programs over time, Brint et al. (2009) treated various terms used by individual programs interchangeably (e.g., interdisciplinary and multidisciplinary). For inclusion in their categorization of interdisciplinary programs, these authors required that at least two-thirds of the programs within a particular field (e.g., women's studies) draw on faculty members from more than one academic department. Typologies of interdisciplinary programs might be improved if they were able to account for local variations in the structure and organization of curricula.

Thus, the goal of our study was to characterize undergraduate interdisciplinary programs in preparation for subsequent studies of the potential impact of these variations on students' learning. *Specifically, we explored the variation of curricular arrangements and organizational features that previous studies have not yet investigated.*

Conceptual Framework

The Academic Plan model (Fig. 1) describes an array of influences on curriculum planners as they create and revise academic plans for courses and programs (Lattuca and Stark 2009). So as to inform research and practice, the model seeks to promote consideration of factors that influence curricular decisions at the course, program, and institutional levels. The model assumes that faculty members are key actors in curriculum development and revision but also that their curricular plans are influenced by a variety of forces both inside and outside their institutions.

Figure 1 illustrates a broad definition of the term *curriculum* with implications for how we think about educational programs. The box entitled "Academic Plan" consists of elements, or decision points that faculty members address, whether intentionally or not, as they develop courses and programs. Although some consider instruction separate from curriculum, this definition makes it clear that instruction is a critical element of every curriculum plan.

In addition to the elements that define the academic plan itself, the model makes explicit the many factors that influence the development of such plans. First, it acknowledges the influence of socio-cultural and historical factors by embedding the academic plan in this

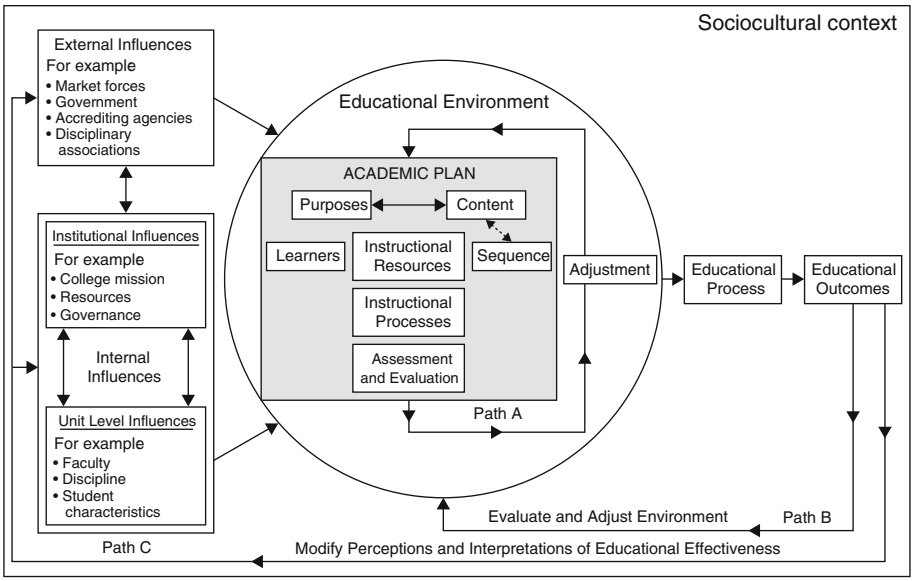

Fig. 1 Academic plan in sociocultural context (Lattuca and Stark 2009)

temporal context. Within this socio-cultural context, two subsets of influences are apparent: 1) influences external to the institution, such as student demand and the expectations of accreditation agencies, and 2) influences internal to the institution. Internal influences are further divided into institutional-level influences (e.g., mission, leadership, and resources) and unit-level influences (e.g., program goals and faculty beliefs). Educational processes and outcomes are placed outside the educational environment to recognize that many influences are beyond the control of planners. These include, for example, the academic preparation of students who enroll in a course. Finally, Fig. 1 portrays several evaluation and adjustment paths, including adjustment for a course or program, influences of an academic plan on the educational environment, and the influence of external and internal audiences that form perceptions and interpretations of educational outcomes.

According to this conceptual model, program contexts influence curricular decisions which in turn influence students' learning. It thus becomes important to develop an understanding of the program contexts in which interdisciplinary education takes place *before* we can understand student learning in these programs. In this article, we focus on the internal influences that are typically within the control of the faculty or academic leaders. External forces are largely beyond administrative or faculty control, for example, industry and government demands for interdisciplinary programs as described previously (e.g., U.S. Department of Education 2006).

Internal Influences

Internal influences interact to create the educational environment in which academic plans are created. Faculty perceptions are important internal influences that shape curricula at the program level (Lattuca and Stark 2009). The Contextual Filters model proposed by Stark et al. (1988) identified a variety of personal and institutional

factors that influence faculty members as they plan curricula. The model posits that personal factors, such as views of one's discipline and beliefs about education, strongly influence curricular choices, which was corroborated by data from a national study testing this model (Stark et al. 1990).

The Contextual Filters model also posits that local contexts influence the decisions faculty members make about their courses (Stark et al. 1988; Toombs and Tierney 1991, 1993). Thus, the curricular requirements are, to some extent, dependent on the organizational features of the program and institution. For example, a curriculum for an academic program that is located within a large department may be organized differently than one with greater administrative independence. In interdisciplinary programs, variations in organizational structures include the number of faculty members holding appointments in the program, whether these appointments are full-time or shared between programs, and the extent to which the interdisciplinary program relies on other programs for courses and curricular leadership. Characterizing organizational appointments of faculty members within an interdisciplinary program may provide insight into its students' curricular experiences.

Augsburg and Henry (2009) and Klein (2010a) contended that curricular variation leads to strong and weak models of interdisciplinary programs. These variations include the ratio of required credits within a program to the required credits outside the program and the total number of required credits for the program. Strong programs, they argued, not only require more credits; they also require that students take these credits from a core of interdisciplinary courses. These core courses might include an introductory course as well as a capstone requirement. As such, strong interdisciplinary programs stress the integration of knowledge, whereas weak programs ask students to choose from a menu of courses that are not intentionally integrated (Augsburg and Henry 2009; Klein 2010a). Integration is thus left primarily to the student, perhaps only stressed in the introductory and capstone courses that students must take. To allow for this more purposeful and cohesive curriculum, strong interdisciplinary programs have higher percentages of faculty members with appointments in the program rather than from contributing departments (Augsburg and Henry 2009; Klein 2010a)

Leadership can also influence and motivate curriculum planning at the program level, as depicted in the Academic Plan (Lattuca and Stark 2009). Because the boundaries of interdisciplinary programs are ever-changing (Klein 2010b), the appointment of a program chair may be very important in how a program responds to changes in the interdisciplinary field and remains at the forefront of the field. In addition, chairs assign instructional staff to courses, provide incentives for faculty members, allocate resources through budgeting, and can select materials and processes to carry out an academic plan (Lattuca and Stark 2009). It stands to reason that program chairs with an appointment within the interdisciplinary program may conduct these duties differently than persons who instead have outside appointments. Furthermore, programs with an appointed director may be more cohesive than those led by part-time leaders whose tenure homes are in a separate unit. Differences in organizational structures may influence curricular decision making and thus students' learning outcomes (Lattuca and Stark 2009). We make the assumption that appointing a program director whose tenure home is within the interdisciplinary program indicates greater institutional support for the program. Such an organizational structure is a characteristic of strong interdisciplinary programs according to Augsburg and Henry (2009) and Klein (2010a).

Thus, our analysis of interdisciplinary programs examined such variables as a part of curricular and organizational structures that previous studies have not yet investigated.

Data and Methods

This research was conducted in preparation for a larger study that will use data from 37 institutions participating in the Wabash National Study (WNS) of Liberal Arts Education (see Table 1) to investigate student learning in interdisciplinary undergraduate programs. We intentionally selected the WNS database for our sample because of the availability of longitudinal student-level outcomes data that are linked to specific programs and student experiences.

We drew upon data housed on the 37 institutions' websites related to program-level organizational features and curricular requirements for interdisciplinary programs. This sample included 408 interdisciplinary programs at those 37 institutions that offer majors in accord with the groupings of interdisciplinary programs produced by Brint et al. (2009), which classified academic programs by content areas (see Table 2). Curriculum research suggested this content-based classification may be insufficient because it does not account for organizational features which influence curriculum planning (e.g., Lattuca and Stark 2009).

To explore the usefulness of content-based groupings and other approaches to classifying interdisciplinary programs, we collected the following information from electronic academic catalogs and marketing materials for each interdisciplinary program at the institutions in the WNS database: presence of integrated courses in the curriculum, use of team teaching as an instructional practice of the program, percentage of credits required from the interdisciplinary program for graduation, percentage of credits required from other programs for graduation, field experience/internship requirement, capstone requirement, undergraduate thesis requirement, service learning component, presence of project-based learning, nature of program director's organizational affiliation (within or outside the program), and percentage of faculty members with appointments in the interdisciplinary program—these relate to characteristics of strong interdisciplinary programs.

From these data we determined that the following sets of variables exhibited sufficient variation across the sample of programs to produce a useful typology and were consistent with the literature on strong and weak interdisciplinary programs:

Table 1 Institutions from which data from interdisciplinary programs were collected

Allegheny College	Drew University	Salem State University
Alma College	Fairfield University	San Jose State University
Alverno College	Franklin College	UNC Wilmington
Augustana College	Hamilton College	University of Michigan
Bard College	Hobart and William Smith Colleges	University of Notre Dame
Blackburn College	Hope College	University of Rhode Island
Brandeis University	University of Kentucky	Vassar College
Butler University	Lasell College	Warren Wilson College
Coe College	Millersville University	Wheelock College
College of the Holy Cross	New College of Florida	Whittier College
Columbia College	North Carolina A&T	Worcester Polytechnic Institute
Connecticut College	Ripon College	Worcester State University
Delaware State		

Table 2 Content groupings of interdisciplinary programs used by Brint et al. (2009) and examples of programs included in each grouping

Interdisciplinary Content	Example Programs
Non-western Cultural Studies	Asian area studies, Latin American studies, African area studies
Race and Ethnic Studies	African American studies, Race/ethnic studies, Hispanic studies
Western Studies	European, North American studies, Western period studies
Environmental Studies	Environmental sciences, Geosciences
International/Global Studies	International/global studies, Peace studies, Political economy
Civic/Governmental Studies	Urban studies, Public affairs, Public policy, Legal studies
Women's Studies	Women's Studies
American Studies	American culture/studies, U.S. regional studies
Brain and Biomedical Science	Cognitive, neuroscience, Biological psychology, Biochemistry
Other	Film studies, Liberal studies, Gerontology

1) *Curriculum requirements*: We included measures of the percentage of total required credits within the interdisciplinary program and the total number of required credits for graduation.
2) *Organizational features:* We included measures of the percentage of the faculty members with an appointment within the program and whether or not the program director's appointment is within or outside the program.

Other variables, such as team teaching, for example, were more difficult to glean from academic catalogs and marketing materials. Because only a small percentage of programs listed useful information for these variables, we limited the final variables used in the typology to the curricular requirements and organizational features.

We then conducted three separate cluster analyses to categorize programs based on: 1) curricular requirements (two variables), 2) organizational features (two variables), and 3) a combination of curricular requirements and organizational features (four variables). Cluster analysis is a statistical technique that identifies homogeneous groupings within a sample. It seeks to minimize within-group variance and maximize between-group variance (Borden 2005; Everitt et al. 2011).

We transformed each variable so that it could be appropriately compared in the cluster analysis; this transformation was necessary because the variables employ different measurement units and vary in magnitude (Gnanadesikan et al. 1995; Hunt and Jorgensen 2011; Jain et al. 1999; Milligan and Cooper 1988; Rapkin and Luke 1993, as cited in Bahr et al. 2011). Had we not taken this step, the total number of credits required would have driven the cluster groupings because this variable has a much larger magnitude relative to the other variables. To standardize the variables, the mean of a given variable was subtracted from each value of that variable; and then the difference was divided by the standard deviation so that the new variable had a mean of zero and a standard deviation of one (Bahr et al. 2011).

Though many education research studies have used only the *k*-means method, we preferred the two-stage method; we first used a hierarchical cluster technique to identify cluster starting points and the potential numbers of clusters to run. This first step informed the nonhierarchical *k*-means method in the second step, which requires the researcher to indicate the number of clusters (*k*) when initializing the procedure (Everitt et al. 2011; Hunt and Jorgensen 2011; Rapkin and Luke 1993). Following procedures recommended by Milligan (1980) and Steinley (2007), we used Ward's (1963) method in stage one to identify

the numbers of clusters to run (using dendrograms) and calculated initial seeds for the *k*-means cluster analysis from these solutions.

We then used the iterative *k*-means method to produce the final clusters for analysis and completed this *k*-means analysis for each of the *k* numbers of clusters to be explored, as identified in stage 1. Comparisons of the grouping variables were made for each set of cluster solutions, and we identified a final solution based on the number of cases falling in each cluster as well as the ability of the cluster solution to provide meaningful distinctions between interdisciplinary programs. For example, a nine-cluster solution with one cluster containing only two programs would be useless for further analysis. In situations like this, we examined a solution producing fewer clusters.

The methods used to obtain data as well as the WNS sample of institutions had several limitations. As previously indicated, we did not use all of the variables collected for the cluster analyses because 1) they did not exhibit sufficient variance across programs and 2) they lacked completeness and, in all likelihood, accuracy. For example, it was difficult to understand the nature of team teaching or capstone courses based on information from a website alone. Time and human resource constraints prevented us from contacting the 408 programs in this study. Future research should contact program directors to ensure that such variables are included in future analyses. The website data that we decided to use, however, were comprised of factual, catalogue variables. Because listed course requirements often are considered an implied contract between a program and a student, it is likely that curricular changes are updated on websites when such changes occur.

The WNS data set had been purposefully selected because of the availability of longitudinal student-level data that are linked to specific programs. Liberal arts institutions are overrepresented in this sample, so any generalizations that are made from this research must acknowledge that caveat.

Results and Discussion

Findings from these analyses provided evidence that there are many different variations of interdisciplinary programs, both in terms of curricular requirements and organizational features. Distinct clusters of programs emerged based on each of these clustering schemes. We determined that the 5-cluster solution was optimal for the analyses using the curricular requirements variables. According to an analysis of variance, these variables are significantly different across clusters. As shown in Fig. 2a, each cluster clearly occupies a different space in the x-y plane of courses required within the interdisciplinary program versus the total required courses. Programs in Curriculum Cluster 1 require that a majority of courses come from within the interdisciplinary program and that students take anywhere between 20 and 60 total credits for a major. Curriculum Cluster 2 contains programs that require a similar number of overall credits for the major, but these tend to be split between courses within the interdisciplinary program and courses from other programs. Though again similar on the total number of credits required for a major, programs in Curriculum Cluster 3 rely exclusively on courses from other programs to fulfill the interdisciplinary major requirements. Programs in Curriculum Clusters 4 and 5 require that students take more than 55 credits for the interdisciplinary major; however, because a fewer number of programs meet this criterion, these course-heavy programs fall into only two clusters based on the percentage of courses falling within the program. Curriculum Cluster 4 programs rely more on courses from other programs than those grouped in Curriculum Cluster 5.

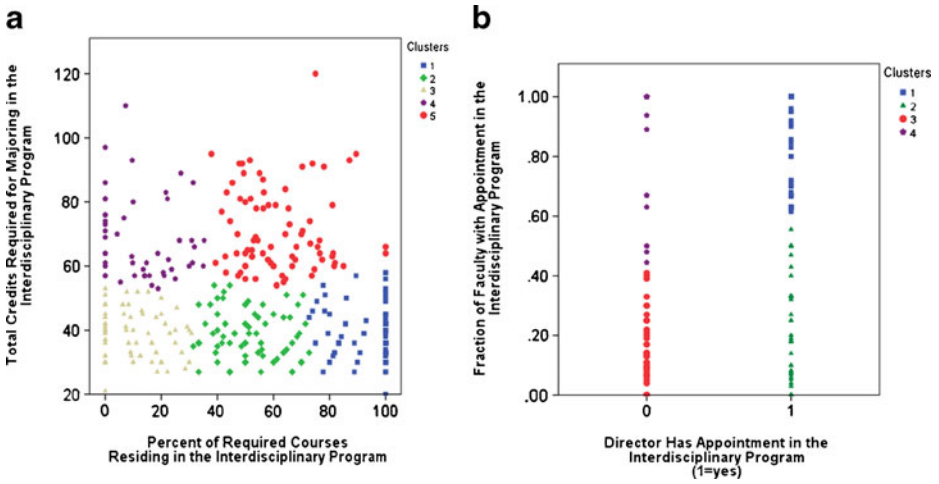

Fig. 2 **a** Five-cluster solution for analysis using two curriculum requirements variables; **b** Four-cluster solution for analysis using two organizational features variables

Because curricular requirements guided this cluster analysis, it stands to reason that the interdisciplinary content groupings identified by Brint et al. (2009) may exhibit patterns across clusters. As shown in Table 3, however, the existence of strong patterns is the exception rather than the norm. If the Non-Western Cultural Studies programs all shared similar curricular requirements, for example, all these programs would fall into a single cluster more frequently than they do. In the most evident pattern across the content groupings, science-based programs (e.g., Environmental Studies, Brain and Biomedical Science, and some of the Other category) tend to occupy Curriculum Clusters 4 and 5 more so than other types of programs. This is not surprising as many interdisciplinary science programs require a strong foundation of mathematics and courses from traditional science disciplines in addition to the coursework for the interdisciplinary major, thus requiring greater numbers of credits for the degree. In looking at these content areas, however, many science-based programs also fall within Curriculum Clusters 1, 2, and 3. This curriculum-based typology provides information that may be useful for characterizing interdisciplinary programs that would not be realized by content areas alone.

The organizational features cluster analysis contained a dichotomous variable (whether or not the director had an appointment within the discipline) as well as a continuous variable (the percentage of the faculty holding an appointment within the interdisciplinary program). As expected, clusters split on the dichotomous variable; and we were left to choose a solution that further divided these two groups of programs by the continuous variable. We selected the 4-cluster solution because further dividing the data into a 5- or 6-cluster solution would yield clusters with only ten cases. Even with this solution, approximately 80% of the programs fall into Organizational Clusters 1 or 3. As depicted in Fig. 2b, programs in Organizational Cluster 1 have program directors appointed in the interdisciplinary program; and most faculty members similarly hold appointments in the interdisciplinary program. The opposite is true for Organizational Cluster 3, as directors of these programs along with most faculty members affiliated with the program have appointments in other programs. Though Organizational Clusters 2 and 4 contain fewer programs, the

Table 3 Frequency of programs by cluster and Brint et al. (2009) content grouping for the cluster analysis based on the two curriculum requirements variables

Brint et al. (2009) Interdisciplinary Content Groupings	Clusters					Total
	1	2	3	4	5	
Non-western Cultural Studies	7	9	18	2	0	36
Race and Ethnic Studies	7	2	1	0	1	11
Western Studies	9	9	5	1	4	28
Environmental Studies	8	8	14	9	29	68
International/Global Studies	0	4	12	5	2	23
Civic/Governmental Studies	3	6	4	0	3	16
Women's Studies	4	11	2	0	1	18
American Studies	1	6	5	2	0	14
Brain and Biomedical Science	0	5	11	23	9	48
Other	47	30	25	10	34	146
Total	86	90	97	52	83	408
Position on the Strong–Weak Continuum[a]	Strong	Middle	Weakest	Weak	Strongest	

[a] This is based on the strong–weak characteristics of interdisciplinary programs proposed by Augsburg and Henry (2009) and Klein (2010b)

presence of a program director with an appointment that is different than that of most faculty members within the program may influence curricular decision-making and thus affect student experiences.

Much like the cluster analysis using curriculum requirements, the clusters using the organizational features variables exhibit no apparent patterns across the Brint et al. (2009) groupings by content area (Table 4). As such, we concluded that incorporating information about organizational features into a typology of interdisciplinary programs is also valuable for characterizing these programs. Knowing a program's content area alone is insufficient for confidently predicting the organizational features.

Comparisons between the curriculum-based cluster analysis and the organizational-based cluster analysis provided insight on whether or not we can better understand interdisciplinary programs by examining all of these variables. If we gain no new information, the two clustering solutions would display considerable overlap. As shown in Fig. 3, this is not the case at all. In fact, with few exceptions, the curriculum clusters are fairly well-distributed among the organizational clusters. This evidence supported a third cluster analysis that included all four curricular requirements and organizational features variables because we clearly gained additional information for characterizing interdisciplinary programs.

The radar plot (Fig. 4) shows results of the combined cluster analysis using all four variables. Because there are inconsistent units across these four variables, we used the standardized variables in this graphical display. Six unique clusters emerge from this analysis, and each describes interdisciplinary programs with unique characteristics. Programs in Combined Cluster 1 are distinguished by director and faculty appointments in the interdisciplinary field, tend to require major courses from within the field, but require a fairly low overall number of credits. Combined Cluster 2 programs, rather, require a higher number of total credits for the major. Combined Cluster 2, therefore, would be characterized by Augsburg and Henry (2009) and Klein (2010a) as strong interdisciplinary programs.

Table 4 Frequency of programs by cluster and Brint et al. (2009) content grouping for the cluster analysis based on the two organizational features variables

Brint et al. (2009) Interdisciplinary Content Groupings	Clusters				Total
	1	2	3	4	
Non-western Cultural Studies	5	7	22	2	36
Race and Ethnic Studies	7	1	1	2	11
Western Studies	13	3	10	2	28
Environmental Studies	40	4	24	0	68
International/Global Studies	4	4	14	1	23
Civic/Governmental Studies	4	3	9	0	16
Women's Studies	3	6	8	1	18
American Studies	4	4	6	0	14
Brain and Biomedical Science	9	12	25	2	48
Other	87	14	38	7	146
Total	176	58	157	17	408
Position on the Strong–Weak Continuum[a]	Strong	Middle	Weak	Middle	

[a] This is based on the strong–weak characteristics of interdisciplinary programs proposed by Augsburg and Henry (2007) and Klein (2010b)

The director of programs in Combined Cluster 3 also tends to have an appointment within the interdisciplinary program, but only a fraction of the faculty shares such an appointment. Instead they have appointments from other units. Students thus rely on courses offered by other programs to complete the major, and the total number of credits required for the major is fairly low. Programs in Combined Cluster 5 are distinct from those in Combined Cluster 3 because the appointment of the director in the former grouping tends to be in another discipline. As such, Combined Cluster 5 represents the prototypical programs that Augsburg and Henry (2009) and Klein (2010a) would characterize as "weak" interdisciplinary programs. Faculty members and directors of programs in Combined Clusters 4 and 6 also tend to have appointments in programs other than the interdisciplinary program. Differences in the curricular requirements differentiate them from one another. Programs in Combined Cluster 4 require a high percentage of courses from within the interdisciplinary

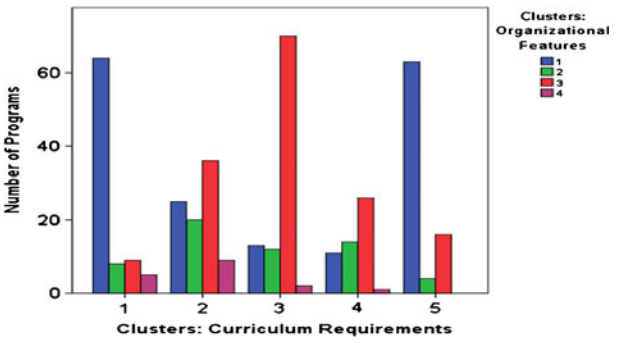

Fig. 3 Overlap of the solutions from the cluster analysis using curricular requirements variables and the cluster analysis using organizational features variables

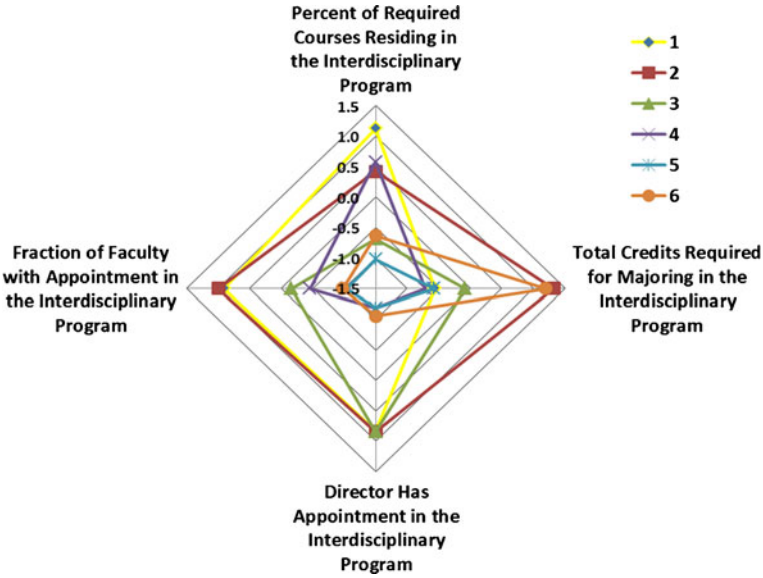

Fig. 4 Radar plot of the mean standardized curriculum requirements and organizational features variables for the six-cluster solution

program but fewer total credits, and programs in Combined Cluster 6 require a high number of total credits but a lower percentage from within the interdisciplinary program. These clusters each have characteristics of both "strong" and "weak" interdisciplinary programs (Augsburg and Henry 2009)—we would characterize Cluster 4 as being stronger as a stand-alone program because of the within-program credit requirement.

We also compared the combined cluster solution to the content groupings of interdisciplinary programs by Brint et al. (2009) (see Table 5). Programs from each content grouping are fairly well spread across the combined clusters, with few exceptions. Notably, however, three content groupings do not have programs represented in Combined Cluster 2, which best resembles the "strong" interdisciplinary prototype: Non-western Cultural Studies, Women's Studies, and American Studies. Such content areas are commonly pointed to as examples of interdisciplinary programs, so it is surprising that none fall into this cluster. Total credit requirements tended to be lower for these interdisciplinary programs, however, so as to allow students to obtain a second major (for the programs in our sample). Women's Studies programs often began as minors and became majors over time, and early American Studies programs were options for those seeking teaching degrees, so the low number of total required credits may reflect the history of these programs initially as "add-ons" to traditional discipline-based majors. As opposed to "ethnic studies" programs that tend to resemble the curricula of Women's Studies programs, Non-western Cultural Studies are "area studies," which have historically combined course offerings from multiple fields rather than offering an integrated curriculum. These rationales may explain why these interdisciplinary programs do not fall within the strong prototype.

Race and Ethnic Studies is the only content grouping not represented in the prototypical weak interdisciplinary Cluster 5. Perhaps this demonstrates an institution's commitment to diversity as programs categorized within this cluster tended to have directors and faculty appointments within the interdisciplinary major program, thereby placing them in a different

Table 5 Frequency of programs by cluster and Brint et al. (2009) content grouping for the cluster analysis based on the two curricular requirements variables and the two organizational features variables

Brint et al. (2009) Interdisciplinary Content Groupings	Clusters						Total
	1	2	3	4	5	6	
Non-western Cultural Studies	6	0	6	8	16	0	36
Race and Ethnic Studies	6	1	1	3	0	0	11
Western Studies	11	2	3	5	4	3	28
Environmental Studies	10	29	5	2	14	8	68
International/Global Studies	0	2	6	2	9	4	23
Civic/Governmental Studies	3	1	3	4	3	2	16
Women's Studies	3	0	6	5	3	1	18
American Studies	4	0	4	0	6	0	14
Brain and Biomedical Science	0	5	13	1	12	17	48
Other	53	28	20	16	19	10	146
Total	96	68	67	46	86	45	408
Position on the Strong–Weak Continuum[a]	Strong	Strongest	Middle	Middle	Weakest	Middle	

[a] This is based on the strong–weak characteristics of interdisciplinary programs proposed by Augsburg and Henry (2007) and Klein (2010b)

cluster. This commitment may derive from the history of these programs, which were established in the 1960s and 70s in response to students' and faculty members' demands that more curricular attention be accorded to those whose histories were not represented in the mainstream curriculum (Lattuca and Stark 2009; Wilson 1999).

In general, however, the spread of programs across the six clusters by content area shown in Table 5 provided further evidence that we should consider both curricular requirements and organizational features rather than content alone when characterizing interdisciplinary programs. Our results demonstrated multiple curricular and organizational structures within each of Brint et al.'s (2009) interdisciplinary content areas. It is important to note that such findings suggest that student learning experiences within a content grouping of interdisciplinary programs may also vary. Thus, objectives should be explicitly stated when directives call for more interdisciplinary learning opportunities because local variation exists even within the same field.

Implications and Future Work

Those calling for interdisciplinary education have been pressuring the academy to change the way in which it organizes departments, structures curricula, and views knowledge. Because problems of modern-day society have grown in complexity, they argue, interdisciplinary approaches have become necessary to reach effective and innovative solutions. In response, the undergraduate curricula have broadened to include more programs that take interdisciplinary approaches, presumably promoting students' abilities to synthesize and integrate information from different disciplines. Little research, however, has examined the effects of these programs on students' learning outcomes. Analyses of learning outcomes have largely been limited to single-institution studies with few statistical controls to account for entering student characteristics.

Our research sought to characterize interdisciplinary educational experiences as a first step toward answering questions about the learning outcomes of undergraduates in interdisciplinary programs and sources of variation in these learning outcomes. Findings showed that considering content alone is insufficient for characterizing interdisciplinary programs; our typology demonstrated that variations in curriculum requirements and organizational features should also be considered when classifying interdisciplinary programs. Our results were consistent with the conceptualization of organizational influences on the curriculum as posited by the Academic Plan model (Lattuca and Stark 2009). That model suggests that these organizational and curricular features ultimately, if indirectly, will affect student learning. This assumption coincides with Augsburg and Henry's (2009) claim that strong and weak interdisciplinary programs differentially influence student outcomes, in this case students' integrative skills. Though our work here provided empirical support for the presence of strong and weak interdisciplinary programs, more research is needed to understand if and how variations in program "strength" affect student learning. In future analyses, we will merge these program characteristics with student-level outcome data. Using this typology, we can begin addressing questions about whether different types of interdisciplinary programs are associated with different kinds or levels of student learning outcomes. Because weak interdisciplinary programs tend to be most vulnerable during times of financial stress (Augsburg and Henry 2009), having empirical evidence on the student learning that happens within such programs would be a useful guide for decision makers. Moreover, future work will make a valuable contribution to the literature on interdisciplinary teaching and learning, which is unfortunately lacking strong empirical evidence of program impacts on student outcomes.

Researchers should address some of the limitations of this study in future work. Because we relied on websites that may be outdated or contain erroneous information to determine curricular requirements and organizational features, future work should include contacting program chairs to ensure accurate and up-to-date information. Now that we have evidence of multiple types of interdisciplinary programs, we have a basis for refining our typology and using it to study whether and how student learning may vary across program types—presently, our research team is conducting this next study of student learning using data from the Wabash Study. As resources are directed toward the initiation of interdisciplinary programs, results of our research can help guide policymakers to be more explicit in the types of program they seek to fund.

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